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the member of high permeability being a shield layer spaced from the  
ferromagnetic tunnel junction element.

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34  
17. (Twice Amended) A hard disk device comprising the magnetic head  
according to claim 5 or 7.

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### REMARKS

Attached hereto is a marked-up version of the changes made to the claims by  
the current amendment, captioned "**Version with markings to show changes made.**"

As a preliminary matter, applicants request consideration of the references filed  
in an Information Disclosure Statement filed on June 12, 2000. A copy of the statement and  
Form PTO 1449 is attached. English language abstracts of the publications filed with that  
statement were mailed on May 30, 2001. A copy of that statement is also enclosed. Copies  
of the references can be provided on request.

As another preliminary matter, applicants request an explanation as to why the  
references cited by applicants on June 24, 2002 apparently were not considered, because they  
were lined out without comment.

Claims 5 and 6 have been amended to overcome the outstanding objection.  
Withdrawal is requested.

Claims 1-6 stand rejected under § 102(e) on the basis of Noguchi et al. '022. Applicants respectfully traverse this rejection because the cited reference does not disclose (or suggest) a first region being a region inside the edge part of a barrier layer, as in claim 1, as amended to overcome this rejection.

The examiner asserts that Noguchi et al (Fig. 46) shows a magnetic sensor including a barrier layer (210+213) having a smaller thickness in a first region (D1), a region of the free layer corresponding to the first region (D1) functioning as a sensor portion for sensing an external magnetic field. However, in Noguchi et al., the region (D1) includes an edge part of the barrier layer (210+213).

In the present invention, the first region is a region inside the edge part of the barrier layer. Generally, the region inside the edge part of the barrier layer is a region where the influence of the demagnetizing field is low. In the present invention, since a region except the edge part functions as a sensor portion for sensing an external magnetic field, it is possible to obtain a large rotation angle of a magnetic direction in the sensor portion. Consequently, in the present invention, it is possible to obtain a magnetic sensor having sufficiently high detection sensitivity. Claims 2-6 are dependent on claim 1, and are allowable for the same reasons. For these reasons, reconsideration and withdrawal of this rejection is respectfully requested.

Claims 7-9, 14 and 17 stand rejected under § 102(e) on the basis of Gill '177. Applicants respectfully traverse this rejection because the cited reference does not disclose

(or suggest) an end portion of a free layer being extended from a ferromagnetic tunnel junction element, and connected to a shield layer of high permeability spaced from the ferromagnetic tunnel junction element, as now recited in claim 7, as amended, to overcome this rejection.

The examiner asserts that Gill (Fig. 9) shows a magnetic head comprising a free layer (210) connecting to a member of high permeability (212).

In claim 7, an end portion of the free layer is extended from the ferromagnetic tunnel junction element, and is connected to a shield layer of high permeability spaced from the ferromagnetic tunnel junction element. Since the end portion extended from the ferromagnetic tunnel junction element is connected to the shield layer of high permeability spaced from the ferromagnetic tunnel junction element, it is possible to reduce the influence of the demagnetizing field in the free layer. Therefore, it is possible to obtain a large rotation angle of a magnetic direction in the junction region. Consequently, it is possible to obtain a magnetic head having sufficiently high detection sensitivity. Claims 8, 9, 14 and 17 depend from claim 7, and allowable over the cited reference for the same reason. For these reasons, reconsideration and withdrawal of this rejection is respectfully requested.

Claims 7, 8, 11, 12 and 15 stand rejected under § 103 on the basis of Noguchi et al. and Gill. Claim 10 stands rejected on the basis of Gill and Sakakima et al., and claim 13 stands rejected on the basis of Gill and Fujishima et al. Claims 16 and 18 stand rejected as being unpatentable over Gill in view of ordinary skill in the art at the time of the invention.

Applicants traverse these rejections because the feature of independent claim 7, that an end portion of a free layer is extended from a ferromagnetic tunnel junction element, and the end portion of the free layer is connected to a shield layer of high permeability spaced from the ferromagnetic tunnel junction element, is not disclosed or suggested in any of the references.

Reconsideration and withdrawal is respectfully requested.

For the foregoing reasons, applicants believe that this case is in condition for allowance, which is respectfully requested. The examiner should call applicants' attorney if an interview would expedite prosecution.

Respectfully submitted,

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By 

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November 14, 2002

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F:\DATA\WP60\1111\64360\Amend A.doc

**VERSION WITH MARKINGS TO SHOW CHANGES MADE****In the Claims:**

Claims 1, 5, 6, 7 and 17 were amended as follows:

1. (Amended) A magnetic sensor including a ferromagnetic tunnel junction, comprising:

a free layer a magnetic direction of which freely rotates; and

a barrier layer formed on the free layer and having a smaller thickness in a first region,

a region of the free layer corresponding to the first region functioning as a sensor portion for sensing an external magnetic field;

the first region being a region inside the edge part of the barrier layer.

5. (Twice Amended) A magnetic head comprising the magnetic sensor according to claim 1, 4 or 2.

6. (Twice Amended) A magnetic encoder comprising the magnetic sensor according to claim 1, 4 or 2.

7. (Amended) A magnetic head comprising a ferromagnetic tunnel junction element including a free layer, a magnetic direction of which freely rotates, and a fixed layer which is opposed to one surface of the free layer through a barrier layer, and a magnetic direction of ~~which is the fixed layer being~~ fixed by a an antiferromagnetic layer which is adjacent thereto,

an end portion of the free layer being extended from the ferromagnetic tunnel junction element, and being connected to a member of high permeability,

the member of high permeability being a shield layer spaced from the ferromagnetic tunnel junction element.

17. (Twice Amended) A hard disk device comprising the magnetic head according to claim 5 or 7 ~~or 8~~.



1111.64360

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re U.S. Patent Application )

Applicant: Sato et al. )

Cont. of: PCT/JP99/05568 )

Filed: October 8, 1999 )

For: MAGNETIC SENSOR,  
MAGNETIC HEAD,  
MAGNETIC ENCODER AND  
HARD DISK DEVICE )

Art Unit: )

I hereby certify that this paper is being deposited with  
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06/12/00

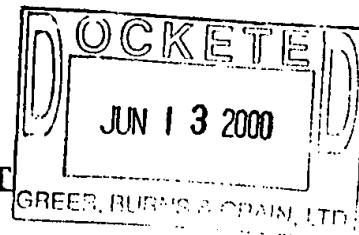
Date

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Technology Center 2600

INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

In accordance with 37 C.F.R. §§1.56, 1.97 and 1.98, Applicants through  
counsel herewith submit copies of the publications as set forth in the attached form PTO-  
1449 as follows:

U.S. PATENT DOCUMENTS

<u>PATENT NO.</u>	<u>PATENTEE</u>	<u>ISSUE DATE</u>
5,729,410	Fontana, Jr. et al.	Mar. 17, 1998

FOREIGN PATENT DOCUMENTS

<u>DOCUMENT NO.</u>	<u>COUNTRY</u>	<u>PUBLICATION DATE</u>
831.541	Europe	Mar. 25, 1998
872.828	Europe	Oct. 21, 1998

791 916	Europe	Aug. 27, 1997
7-73419	Japan	Mar. 17, 1995
10-69609	Japan	Mar. 10, 1998
9-245318	Japan	Sep. 19, 1997

Applicants respectfully request that the Examiner consider the above-listed references in the examination of this application and list these references of record in the application.

Respectfully submitted

GREER, BURNS & CRAIN, LTD.

By



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June 12, 2000

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Form PTO-1449  
(Rev. 8-88)U.S. Department of Commerce  
Patent and Trademark OfficeAttorney Docket No.  
1111/64360Cont of.  
PCT/JP99/05568INFORMATION DISCLOSURE CITATION  
(Use several sheets if necessary)

Applicant:: Sato et al.

Filing Date: 10-8-99

Group No.

## U.S. PATENT DOCUMENTS

Examiner initial*	Document No.	Date	Name	Class	Subclass	Filing Date
H917	5 7 2 9 4 1 0	Mar. 17, 1998	Fontana, Jr. et al.			

## FOREIGN PATENT DOCUMENTS

Document No.	Date	Country	Class	Subclass	Translation Yes No
MSB 8 3 1 5 4 1	Mar. 25, 1998	Europe			X
MSB 8 7 2 8 2 8	Oct. 21, 1998	Europe			X
MSB 7 9 1 9 1 6	Aug. 27, 1997	Europe			X
MSB 7 7 3 4 1 9	Mar. 17, 1995	Japan			X
MSB 1 0 6 9 6 0 9	Mar. 10, 1998	Japan			X
MSB 9 2 4 5 3 1 8	Sep. 19, 1997	Japan			X

## OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)


Examiner

Date Considered

1/21/03

\*Examiner: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

(19)



JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **09106514 A**

(43) Date of publication of application: 22.04.97

(51) Int. Cl

**G11B 5/39**  
**H01L 43/00**

(21) Application number: **07259938**

(22) Date of filing: **06.10.95**

(71) Applicant: **FUJITSU LTD**

(72) Inventor: **UZUMAKI TAKUYA**  
**YAMAGISHI WATARU**  
**KOBAYASHI KAZUO**

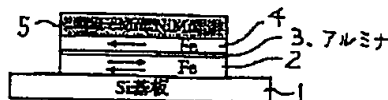
(54) **FERROMAGNETIC TUNNEL ELEMENT AND ITS PRODUCTION**

COPYRIGHT: (C)1997,JPO

(57) Abstract:

**PROBLEM TO BE SOLVED:** To produce a magnetic sensor having excellent characteristics showing large change in the resistance in a weak magnetic field with good production yield by forming a tunnel joint of a three-layer structure of ferromagnetic layer/ insulating layer/ferromagnetic layer and forming an antiferromagnetic layer on the outside of the one ferromagnetic layer of the tunnel joint.

**SOLUTION:** A Si substrate is laminated with a Fe film 2 as a ferromagnetic film, an alumina film 3 as a tunnel insulating film, a Fe film 4 as a ferromagnetic film, and a FeMn film or NiMn 5 as an antiferromagnetic film. Since FeMn grows as  $\gamma$ -FeMn on NiFe, it shows antiferromagnetism in an As-deposited state. On the other hand, NiMn is not antiferromagnetic in an As-deposited state but forms a regular grating by heat treatment and changes into an antiferromagnetic material. Therefore, the element having NiMn is heat treated in vacuum.



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JAPANESE PATENT OFFICE

## PATENT ABSTRACTS OF JAPAN

(11) Publication number: 09251618 A

(43) Date of publication of application: 22.09.97

(51) Int. Cl.

G11B 5/39

(21) Application number: 08062201

(22) Date of filing: 19.03.96

(71) Applicant: FUJITSU LTD

(72) Inventor: TANAKA ATSUSHI  
SATO MASASHIGE

## (54) MAGNETIC SENSOR

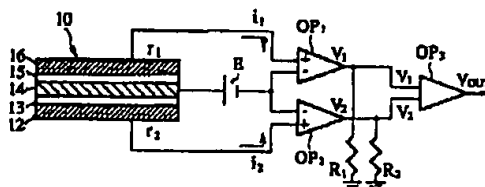
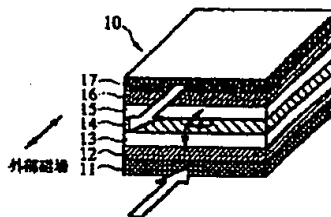
## (57) Abstract:

**PROBLEM TO BE SOLVED:** To provide a magnetic sensor improved in signal-to-noise ratio and high in magnetic field sensitivity by detecting an external magnetic field based on tunnel resistances among magnetic substance layers and obtaining the difference between resistances which are complementarily changed under the external magnetic field.

**SOLUTION:** An antiferromagnetic body layer 11 and an antiferromagnetic body layer 17 mutually reversibly pin the magnetization direction of a ferromagnetic body layer 12 and the magnetization direction of a ferromagnetic layer 16. Consequently, magnetizations of the layer 12 and the layer 16 are pinned to directions opposite with each other. The corrective force of a soft magnetic material layer 14 is small and the direction of magnetization of the layer 14 freely rotates according to the external magnetic field. The direction of the axis of easy magnetization of the layer 14 intersects the magnetization directions of the layer 12, 16 roughly at right angles. Static magnetic fields by the layer 12, 16 are made to be canceled with each other on the layer 14 by adjusting ferromagnetic materials and the thicknesses of the layers 12, 16. When resistances of respective tunnel junctions between the layer 16 and the layer 14 and between the layer 14 and the layer 12 are

defined as  $r_1$  and  $r_2$ , resistances  $r_1$ ,  $r_2$  are complementarily changed by a spin tunnel phenomenon when the magnetization direction of the layer 14 is changed by the external magnetic field. Then, the difference of these changes is detected.

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JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **09282616 A**

(43) Date of publication of application: **31.10.97**

(51) Int. Cl.

**G11B 5/39**

(21) Application number: **08096573**

(22) Date of filing: **18.04.96**

(71) Applicant: **FUJITSU LTD**

(72) Inventor:  
**SATO MASASHIGE  
TANAKA ATSUSHI  
KOBAYASHI KAZUO**

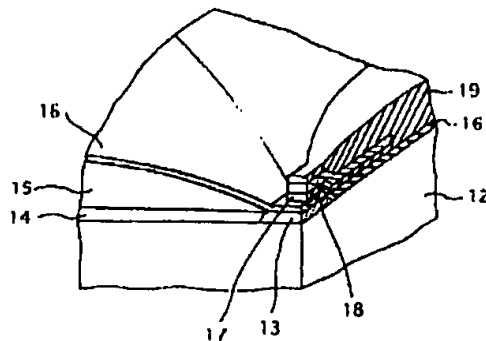
(54) **MAGNETIC HEAD AND MAGNETIC RECORDER**

COPYRIGHT: (C)1997,JPO

(57) Abstract:

**PROBLEM TO BE SOLVED:** To increase the output of a magnetic head formed by using a ferromagnetic tunnel junction element, to prevent the oxidation of the magnetic layers and antiferroelectric layer constituting this ferromagnetic tunnel junction element, to enhance reliability and to deal with a trend toward a much higher recording density.

**SOLUTION:** This magnetic head is composed of the first magnetic layer 13 consisting of a soft magnetic material, the second magnetic layer 17 having the magnetization in a direction orthogonal with the magnetization direction in the initial state of the first magnetic layer 13, the antiferroelectric layer 18 formed on the magnetic layer 17 and an insulating layer 16 which is interposed between the magnetic layers 13 and 17 and tunnel-joins both. The magnetic layer 17 is arranged in the position slightly apart from the end on the magnetic recording medium side and is coated with a coating layer (gap layer) so as not to be exposed on the surface.



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JAPANESE PATENT OFFICE

## PATENT ABSTRACTS OF JAPAN

(11) Publication number: 59195312 A

(43) Date of publication of application: 06.11.84

(51) Int. Cl.

G11B 5/12

G11B 5/25

G11B 5/27

(21) Application number: 58069481

(71) Applicant: NEC CORP

(22) Date of filing: 20.04.83

(72) Inventor: TOKI KAORU

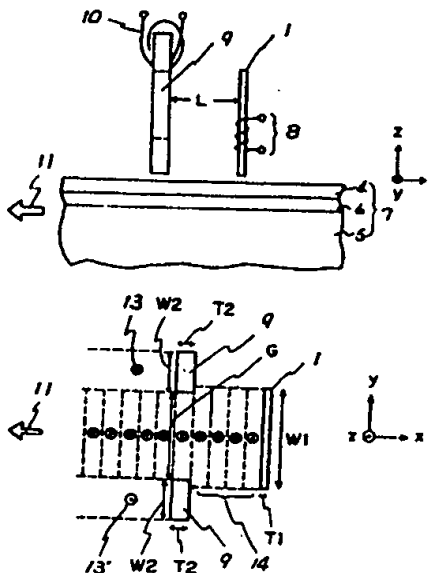
(54) VERTICAL MAGNETIC HEAD

COPYRIGHT: (C)1984,JPO&amp;Japlo

(57) Abstract:

**PURPOSE:** To provide additionally a tunnel erasion function and thereby to improve the off-track characteristics by setting a horseshoe magnetic material of high permeability and a main magnetic pole as opposed to each other so that the horizontal width of the main magnetic pole overlap completely the driving direction of a vertical magnetic recorder to the gap width.

**CONSTITUTION:** A horseshoe magnetic material 9 of high permeability is set at the front side of a main magnetic pole 1 in the driving direction 11 of a vertical magnetic recorder 7. The signal magnetization 14 having a track width  $W1$  is recorded to a recording medium 4 by the pole 1 in response to the drive of the recorder 7. Then magnetizations 13 and 13' of opposite directions to each other with width  $W2$  are recorded with a gap  $G$  by the material 9. The vertical width of the pole 1 overlaps completely the driving direction of the device 7 to the gap  $G$ . Therefore the matter 9 has a function to trim and erase both ends of a recording track 14 recorded by the pole 1. Thus the material 9 has an effective tunnel erasing function to the recorder 7.



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JAPANESE PATENT OFFICE

## PATENT ABSTRACTS OF JAPAN

(11) Publication number: **05250631 A**

(43) Date of publication of application: 28.09.93

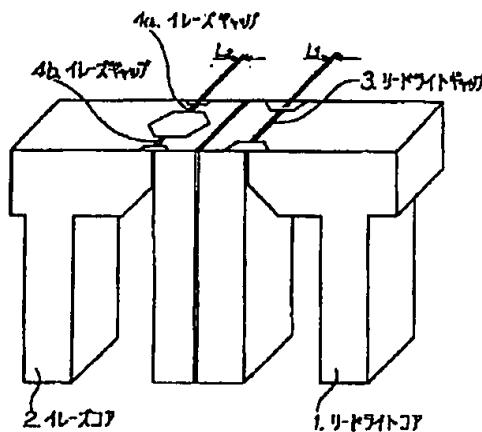
(51) Int. Cl.

**G11B 5/265****G11B 5/127****G11B 5/187****G11B 5/23**(21) Application number: **04049985**(22) Date of filing: **06.03.92**(71) Applicant: **NEC CORP NEC GUMMA  
LTD KOZAN DENKI KOGYO KK**(72) Inventor: **HIRANO ATSUSHI  
NAGASHIMA MITSUO  
MACHIDA KUNIHIRO  
NAGASAWA RYOICHI**(54) **MAGNETIC HEAD**

## (57) Abstract:

**PURPOSE:** To shorten the production lead time by setting the space length of a magnetic gap for writing and reading and the space length of a magnetic gap for tunnel erasing to a specified dimensional relation.

**CONSTITUTION:** This magnetic head is a floppy disk magnetic head for which a read-write core 1 and erase core 2 are coupled with each other. In respective cores 1 and 2, a read-write gap 3 with a space length  $L_1$  and erase gaps 4a, 4b with space length  $L_2$  are formed. Both of lengths  $L_1$  and  $L_2$  are made equal, but while including the error in manufacture the length is set, within the range  $1.2L_1 \leq L_2 \leq 0.8L_1$ . In such a manner,  $L_1$  and  $L_2$  are set to be the same in the production process of the read-write core 1 and the erase core 2, since a sputtering device in the sputtering process of the gap material can be operated simultaneously the production lead time is shortened compared with a conventional method to reduce the production cost.



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JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: 63229609 A

(43) Date of publication of application: 26.09.88

(51) Int. Cl

G11B 5/60

(21) Application number: 62064578

(22) Date of filing: 19.03.87

(71) Applicant: MATSUSHITA ELECTRIC IND CO LTD

(72) Inventor: SEKI TAKAO  
YANAGIDA IKUO  
SAKATA HIROSHI

(54) BOTH SIDES TYPE MAGNETIC HEAD

having a thick magnetic film.

(57) Abstract:

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PURPOSE: To sufficiently read and write a bit of information even from and on a recording medium having a high coercive force or a recording medium having a thick magnetic film by using a ferromagnetic body to attach a magnetic material having a high permeability to a part of a slider in the vicinity of the gap of a read/write core consisting of a ferrite.

CONSTITUTION: A read/write core 1 of a tunnel erase type magnetic head is provided with a read/write gap 3 and a gap nearby core 2 on the side face of the gap 3. The gap nearby core 2 consists of ferromagnetic materials having a high saturation magnetic flux density like a 'Sendust(R)', an amorphous magnetic material, or 'Permalloy(R)'. Since a ferrite is generally used as materials of the main core (read/write core 1), the high frequency characteristic and the wear resistance are satisfactory; and further, the saturation magnetic flux density is raised because ferromagnetic materials like 'Permalloy(R)' are used as materials of a read/write gap nearby core 3. Thus, the information is sufficiently written on and read from even the recording medium having a high coercive force or the recording medium

